

EFFECT OF FOLIAR FERTILIZATION BY AMMONIUM SULPHATE,
SODIUM NITRATE, AND AMMONIUM NITRATE ON THE
MORPHOLOGY AND METABOLISM OF LENTIL
(LENS ESCULENTUS)

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ABSTRACT

An experiment was initiated to study the effect of ammonium sulphate, sodium nitrate, and ammonium nitrate as a foliar spray on the morphology and metabolism of lentil Lens esculentus. Results showed that the three salts increased all growth criteria, nitrogen, carbohydrate contents and also the yield. The most effective salt was ammonium nitrate at 200 ppm.

Recently, many research workers used foliar spray techniques of fertilizers and specific nutrient solutions instead of other techniques as root soaking and soil irrigation because it is more effective to plants. Also foliar spray is the most important aspect of herbicides which are used widely in agriculture by many methods of application.

Saleh et al. (1980) pointed out that foliar spray of ammonium sulphate increased the number of pod clusters in *P. vulgaris*. Seed yields were increased when fertilizers were applied.

Ranganathan et al. (1981) mentioned that if tea bushes were treated by foliar sprays of amm. sulphate, amm. chloride, sod. sulphate, amm. thiocyanate, amm. fluoride and many other salts, yields were reduced by all treatments except in the case of amm. sulphate.

Many experiments cleared that yield of plants increased if sprayed with ammonium sulphate (Aleshin et al., 1982; Banna et al., 1981; Ulmann, 1977; Yadahalli et al., 1974 and Krausko, 1981).

In addition to yield increase of groundnuts by ammonium sulphate foliar spray, the uptake of P, K and N by seeds increased. (Pardole et al., 1982).

Murdock et al., (1979) cleared that ammonium sulphate foliar sprayed to unhealthy maize plants corrected N-deficiency symptoms and significantly increased grain yield.

Grain protein content increased when wheat plants were treated with ammonium sulphate as a foliar spray (Hassan et al., 1973).

In discussing the effect of nitrate -N as a fertilizer for plants, Slamka (1982) cleared that different types of barley showed an increase

in grain protein content with calcium nitrate applied as a foliar spray.

Tomato plants supplied with calcium nitrate showed yield averages more than those supplied with calcium chloride which had no effect on yield. (Verlodt et al., 1977).

Kos'yanenko (1981) demonstrated that foliar spray of ammonium nitrate at the late tillering stage was most effective in increasing yield of barley.

Ammonium nitrate applied as a foliar spray to wheat decreased the percentage of essential amino acids but markedly increased their total contents. (Pavlova et al. 1981). Norden (1981) discovered that application of less than or equal to 20 kg N/ha as a foliar spray of amm. nitrate caused no cereals crop damage.

A foliar spray of ammonium nitrate applied to soyabean at the pod formation stage accelerated aging and increased seed yield and quality (Konechnaya et al., 1978).

In comparing the effect of the three above mentioned salts Spaldon et al., (1978) gave barley different sources of nitrogen in the form of calcium nitrate, calcium ammonium nitrate or ammonium sulphate. All three salts increased crop yield when applied as foliar spray.

MATERIAL AND METHODS

In this experiment ammonium sulphate, sodium nitrate and ammonium nitrate were chosen. The concentrations of these salts were chosen on the basis of a preliminary investigation studying the effect of a wide range of concentrations on the rate of germination and length of protruding radicle.

Seeds of lentil plant were sown in pots and watered whenever needed. After 15 days from sowing the plants were thinned, leaving only the healthy ones.

45 days after sowing, an initial sample was taken before spraying the plants (10 mls of each pot) with a solution containing 0, 100, 200 or 500 ppm of either ammonium sulphate, sodium nitrate or amm. nitrate. 15 days later, another sample was taken, from each treatment before a second spray, with the same amount of solution. A third spray was carried out, 15 days after, and the third sample was taken. Then the harvest was collected.

Plant samples were taken for analysis as mentioned at the age of 45, 60 and 75 days. In all samples, length, fresh and dry weight of stems and leaves as well as pigmentations were determined. In the mean time, the number of flowers, the number of young fruits as well as dry weight of 100 seeds was obtained. Another samples were taken for nitrogen and carbohydrates estimations.

Pigment Estimation

The procedures reported by Metzner et al. (1975) were followed in this investigation.

Determination of Carbohydrates

The procedures mentioned by Nelson (1944), Naguib (1963), and Said & Naguib (1964) were followed.

Estimation of Nitrogen Compounds

The procedures mentioned by Fawcett and Scot (1960), and Chaney and Marbach (1962) were followed in this investigation for ammonia-N estimation.

Russel method (1944) was used for free amino-N determination.

For determining the amount of peptide-N, the procedure of Lowery et al. (1951) was followed.

RESULTS AND DISCUSSION

Table 1 showed that all stages of growth, spraying with ammonium sulphate, sodium nitrate or ammonium nitrate significantly increased all growth criteria at both concentrations of 100 and 200 ppm. The effect progressively increased with progress of age.

This table illustrated that spraying with 500 ppm solutions of the above mentioned salts significantly decreased all morphological criteria (length, fresh and dry weight of stem, number fresh and dry weight, and area of leaves and the number of flowers per plant).

It is also, clear that ammonium nitrate, at different concentrations, was more effective than the other two salts.

If we compare the concentrations to choose the most suitable one as a foliar spray, it becomes obvious that 200 ppm for the three salts is the most suitable since it significantly increased length, fresh and dry weights of stem, leaf number, fresh and dry weights, and area of leaf.

The table also, showed that foliar spraying with ammonium sulphate or sodium nitrate increased the number of flowers at 100 and 200 ppm, but this phenomenon was reversed at 500 ppm. Spraying with these two salts seemed with little or no effect on the number of falling flowers (See table 1). In the mean time ammonium nitrate significantly increased the number of flowers on the plants, and fresh and dry weights of fruits. It is quite striking that ammonium nitrate completely prevented flower drop at all concentrations.

Figures 1-3 showed that on fresh weight basis, one or several sprays with any of the three salts at 200 ppm significantly increased chlorophyll a and carotene and also chlorophyll b except in the ammonium sulphate - treated plants which showed significant drop in chlorophyll b contents.

100 ppm of the three salts had no significant effect on chlorophyll a, b and carotene. On the other hand the three salts at 500 ppm severely lowered the contents of the pigments.

As mentioned before in the section of material and methods, plants were analysed for their various nitrogen compounds. The results

of the analysis are recorded in table 2. The total soluble nitrogen fraction, which is the sum of ammonia-, amino-, peptide- and other nitrogen fractions, did not show significant increase as a result of any of the treatments at the used concentrations.

In the mean time, the protein and other insoluble fractions showed a slight increase under the same treatments. The table also showed significant increase in the total nitrogen content of plants treated with the three salts at 100 and 200 ppm at all stages.

75 days old plants treated with 500 ppm were the only plants which showed no significant increase in their total nitrogen content, this result is similar to that obtained by Lysenko (1980) who demonstrated that a foliar spray of ammonium nitrate increased the seed protein contents and seed yield. Also Gupta et al., (1974) cleared that foliar spray with ammonium sulphate significantly increased total and soluble nitrogen in stems, leaves and grains of rice.

It is quite obvious from table 3 that lentil plants continued to increase, though not much, their total carbohydrate contents by advance of age.

Samples were allowed to grow for yield then taken for analysis. The results are recorded in table 4. From that table it can be seen that both concentrations 100 and 200 ppm of the three salts caused a significant increase in dry weights and total nitrogen contents, the increase being greater with 200 ppm, 500 ppm had no effect except in the case of sodium nitrate which caused a marked decrease in both dry weight and total nitrogen contents. This is agreement with the results obtained by Banna et al., 1981; Ulmann, 1977 and Krausko, 1981 using peach trees, sugar beet and barley.

All treatments seemed to have no significant effect on carbohydrate contents.

Both number of fruits and weight of seeds per plant were not affected in a manner similar to that of carbohydrate content. Ammonium nitrate only at 200 ppm caused significant increase in fruit number as it clear from table 4.

These results could be explained by the fact that coefficients of utilization by plants of N as NH_4 or NO_3 were similar, but fixation of NH_4 N was higher and its loss was smaller than NO_3 N. The utilization of N was far greater when applied at the time of its highest requirements by plants than when applied before sowing. Also the rates of uptake of N as NH_4 and NO_3 applied as foliar spray were similar, but rates of their assimilation differed markedly.

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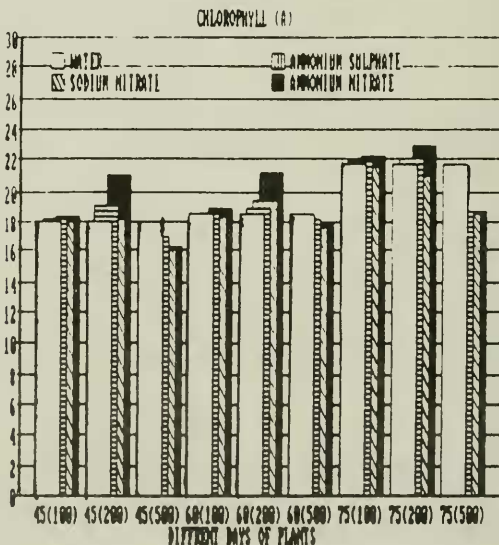


Fig. 1. Effect of foliar spray of different nutrient solutions on chlorophyll a of lentil;

Table 1: Effect of foliar spray of the different nutrient solutions on the morphology of lentil.

Age in days	Salt concentration ppm.	Stem			Leaf			Flowers		Fruits		
		length cm/stem	P. wt. gm/stem	D. wt. gm/stem	No. per plant	F. wt. gm/leaf	D. wt. gm/leaf	Area cm ²	on the plant	Falling	F. wt. gm.	D. wt. gm.
45	00	20.33	1.85	0.295	27	0.61	0.063	8.3	-	-	-	-
	100	Amm. sulphate	22.75**	2.11**	0.339**	34**	0.73**	0.081	10.1*	-	-	-
		Sod. nitrate	21.95**	1.97**	0.329**	29*	0.69*	0.072	9.8*	-	-	-
		Amm. nitrate	25.85**	2.35**	0.451**	37**	0.79**	0.086	11.0**	-	-	-
	200	Amm. sulphate	24.75**	2.15**	0.384**	35**	0.79**	0.089	11.4**	-	-	-
		Sod. nitrate	23.75**	2.08**	0.380**	34**	0.73**	0.083	10.3*	-	-	-
		Amm. nitrate	28.35**	2.96**	0.497**	41**	0.89**	0.119*	14.3**	-	-	-
	500	Amm. sulphate	18.68**	1.89	0.246**	24**	0.51**	0.053	8.0	-	-	-
		Sod. nitrate	18.15**	1.77*	0.200**	22**	0.58**	0.052	8.1	-	-	-
		Amm. nitrate	18.90**	1.97**	0.312*	28	0.57	0.059	9.1	-	-	-
	LSD 5%	0.991	0.078	0.013	1.99	0.067	0.049	1.46	-	-	-	
	1%	1.389	0.109	0.018	2.79	0.094	0.069	2.05	-	-	-	
	00	24.43	1.93	0.301	29	0.69	0.071	9.6	2	-	-	
60	100	Amm. sulphate	26.39**	2.20**	0.309	36**	0.73	0.078	9.9	10**	-	-
		Sod. nitrate	25.74*	2.05*	0.306	35**	0.71	0.076	9.8	8**	-	-
		Amm. nitrate	29.89**	2.44**	0.316	40**	0.80**	0.083	10.1	12**	-	-
	200	Amm. sulphate	28.33**	2.24**	0.321*	37*	0.79**	0.084	10.2	12**	-	-
		Sod. nitrate	27.47**	2.21**	0.316	39**	0.74	0.081	10.0	9**	-	-
		Amm. nitrate	32.91**	3.11**	0.334**	43**	0.89**	0.091	12.3**	14**	-	-
	500	Amm. sulphate	22.71**	2.01	0.299	30	0.69	0.073	9.5	5	-	-
		Sod. nitrate	22.01**	1.92	0.297	29	0.67	0.071	9.3	6	-	-
		Amm. nitrate	23.11*	1.99	0.301	30	0.70	0.075	9.7	7	-	-
		LSD 5%	0.996	0.088	0.018	1.91	0.059	0.042	1.44	1.05	0.76	-
	1%	1.396	0.123	0.025	2.68	0.083	0.059	2.02	1.47	1.06	-	
75	00	30.74	2.14	0.371	32	0.73	0.079	10.4	3	-	-	
	100	Amm. sulphate	32.47**	2.22*	0.397**	36**	0.78*	0.082	10.9	2**	3	1.01
		Sod. nitrate	31.91**	2.17	0.385*	38**	0.76	0.080	10.7	2**	3	1.32**
		Amm. nitrate	35.83**	2.79**	0.401**	41**	0.80**	0.084	11.2	4**	2*	1.28**
	200	Amm. sulphate	34.97**	2.73**	0.403**	38**	0.86**	0.085	11.1	4**	2*	1.57**
		Sod. nitrate	33.09**	2.67**	0.398**	41**	0.80**	0.084	10.9	5*	2**	1.43**
		Amm. nitrate	38.38**	3.03**	0.434**	45**	0.89**	0.091	12.4**	6**	3**	1.98**
	500	Amm. sulphate	28.91**	2.16	0.286**	32	0.74	0.079	10.4	3	-	0.99
		Sod. nitrate	28.03**	2.09	0.381	31	0.72	0.075	10.2	2**	1**	0.91*
		Amm. nitrate	29.37**	2.24**	0.389**	33	0.75	0.080	10.5	3**	**	1.06
	LSD 5%	0.711	0.063	0.013	1.10	0.042	0.042	1.43	1.25	0.79	0.091	
	1%	0.996	0.088	0.018	1.54	0.059	0.059	2.00	1.75	1.11	0.128	

* Results significantly different from control at the 5% level.

** Results significantly different from control at the 1% level.

Table 2: Effect of foliar spray of the different nutrient solutions on the nitrogen content of lentil (mg. N./g. d. wt.).

Age in days	Salt concentrations (ppm)		Nitrogen content			
			soluble	insoluble	Total	
		00	25.26	22.92	48.18	
45	100	Ammonium sulphate	26.93	23.72	50.65**	
		Sodium nitrate	26.41	23.04	49.45*	
		Ammonium nitrate	28.93	24.14	53.07**	
	200	Ammonium sulphate	28.41	24.86	53.27**	
		Sodium nitrate	27.43	24.07	51.50**	
		Ammonium nitrate	30.51	25.24	55.75**	
	500	Ammonium sulphate	24.31	22.85	47.16*	
		Sodium nitrate	24.26	22.41	46.67**	
		Ammonium nitrate	25.01	22.96	47.97	
		LSD	5 %	8.48	6.79	0.985
			1 %	11.89	9.52	1.381
			00	27.32	23.86	51.18
60	100	Ammonium sulphate	28.91	24.26	53.17**	
		Sodium nitrate	28.42	23.98	52.68*	
		Ammonium nitrate	30.97	24.93	55.90**	
	200	Ammonium sulphate	29.21	25.92	55.13**	
		Sodium nitrate	28.32	24.86	53.18**	
		Ammonium nitrate	31.74	26.43	58.17**	
	500	Ammonium sulphate	24.63	23.92	48.55**	
		Sodium nitrate	24.31	23.41	47.72**	
		Ammonium nitrate	25.11	24.01	49.12**	
		LSD	5 %	7.51	6.41	1.139
			1 %	10.53	8.99	1.597
			00	28.37	24.06	52.43
75	100	Ammonium sulphate	29.31	25.12	54.43**	
		Sodium nitrate	29.04	24.83	53.87*	
		Ammonium nitrate	31.06	26.14	57.20**	
	200	Ammonium sulphate	30.31	26.23	56.54**	
		Sodium nitrate	31.47	25.82	57.29**	
		Ammonium nitrate	33.91	27.43	61.34**	
	500	Ammonium sulphate	28.38	24.41	52.79	
		Sodium nitrate	28.27	23.92	52.19	
		Ammonium nitrate	28.94	24.62	53.56	
		LSD	5 %	9.20	9.92	1.413
			1 %	12.90	13.91	1.981

* Results significantly different from control at the 5 % level.

** Results significantly different from control at the 1 % level.

Table 3: Effect of foliar spray of the different nutrient solutions on the carbohydrate content of lentil (mg. glucose / 100 g. d. wt.).

Age days	Salt concentrations	Carbohydrate components				Total	
		T.R.V.	D.R.V.	Sucrose	Poly-saccharide		
100	00	520.90	414.30	106.60	119.80	640.70	
	Ammonium sulphate	530.50	420.40	110.10	122.30	652.80 ^x	
	Sodium nitrate	528.60	418.70	109.90	120.40	649.00	
	Ammonium nitrate	536.90 ^x	424.60	112.30	124.20	661.10 ^{xx}	
45	200	Ammonium sulphate	536.30 ^x	423.90	112.40	123.90	660.20 ^{xx}
	Sodium nitrate	531.30	420.70	110.60	121.70	653.00 ^x	
	Ammonium nitrate	542.50 ^{xx}	428.20	114.30	126.80 ^x	669.30 ^{xx}	
	500	Ammonium sulphate	518.80	413.90	104.90	120.10	638.90
	Sodium nitrate	516.90	412.60	104.30	119.10	636.00	
	Ammonium nitrate	520.00	414.20	105.80	120.90	640.90	
	L S D 5 %	14.82	13.93	8.51	6.97	9.51	
	1 %	20.78	19.53	11.93	9.77	13.33	
	00	528.80	418.90	109.90	123.20	652.00	
	60	100	Ammonium sulphate	533.30	422.10	111.20	123.80
Sodium nitrate		530.60	420.30	110.30	124.60	655.20	
Ammonium nitrate		538.30	425.90	112.40	126.30	664.60 ^x	
200		Ammonium sulphate	539.00	424.40	114.60	126.30	665.30 ^x
Sodium nitrate		535.40	423.10	112.30	124.60	660.00	
Ammonium nitrate		548.00 ^x	430.90	117.10	129.30	677.30 ^{xx}	
500		Ammonium sulphate	525.90	416.70	109.20	123.10	649.00
Sodium nitrate		523.50	416.10	107.40	122.80	646.30	
Ammonium nitrate		527.30	417.20	110.10	123.90	651.20	
L S D 5 %		15.03	14.11	8.73	7.21	9.83	
1 %	21.07	19.78	12.24	10.11	13.78		
00	523.60	421.20	111.40	126.90	659.50		
75	100	Ammonium sulphate	536.10	422.70	113.40	128.20	664.30
	Sodium nitrate	534.70	421.90	112.80	127.60	662.30	
	Ammonium nitrate	539.70	424.80	114.90	128.90	668.60 ^{xx}	
	200	Ammonium sulphate	537.80	423.50	114.30	129.40	667.20 ^x
	Sodium nitrate	537.00	423.30	113.70	128.00	665.00	
	Ammonium nitrate	543.00	426.20	116.80	130.20	673.20 ^{xx}	
	500	Ammonium sulphate	528.50	417.20	111.30	125.40	653.90
	Sodium nitrate	528.20	417.10	111.10	125.30	653.50	
	Ammonium nitrate	530.40	418.30	112.10	125.90	656.30	
	L S D 5 %	15.91	15.02	9.21	8.12	6.04	
1 %	22.31	21.06	12.91	11.38	8.46		

^x Results significantly different from control at the 5 % level.

^{xx} Results significantly different from control at the 1 % level.

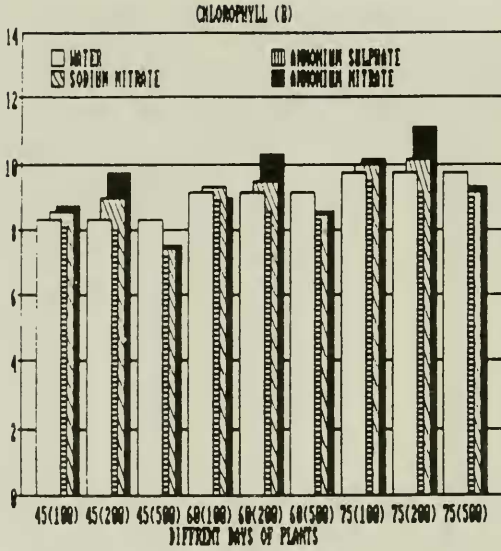


Fig. 2. Effect of foliar spray of the different nutrient solutions on chlorophyll b of lentil;

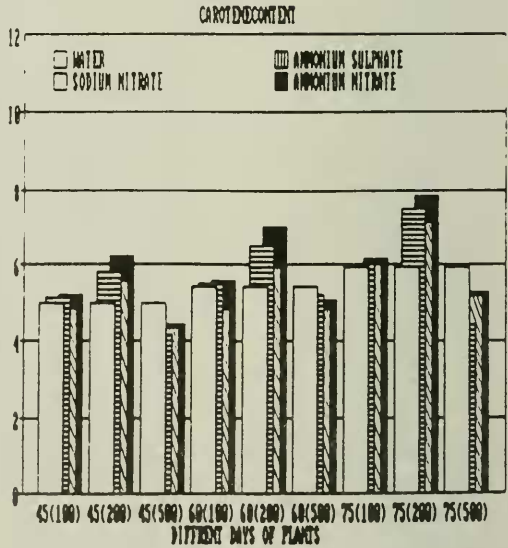


Fig. 3. Effect of foliar spray of the different nutrient solutions on carotene of lentil.

Table 4: Effect of foliar spray of the different nutrient solutions on the yield of lentil.

Salt concentrations ppm	Yield				
	D. Wt. gm/plant	Total N. mg N./g. d. wt.	Total carbohydrate	No./ plant	Fruits mgm seeds/ plant
00	1.98	54.91	661.4	6	582.3
100					
Ammonium sulphate	2.79**	56.28*	663.8	6	586.7
Sodium nitrate	2.47**	55.31	663.2	5	584.2
Ammonium nitrate	3.08**	57.43**	664.9	6	589.3
200					
Ammonium sulphate	2.98**	57.23**	663.9	8	597.6
Sodium nitrate	2.76**	56.97**	663.8	7	593.2
Ammonium nitrate	3.38**	58.42**	666.9	9*	636.7
500					
Ammonium sulphate	1.92	54.32	661.4	5	561.2
Sodium nitrate	1.78**	53.89*	660.8	4	544.9
Ammonium nitrate	1.96	54.63	661.2	5	559.2
LSD at 5 %	0.094	0.985	7.341	2.947	59.00
1 %	0.132	1.381	10.292	4.132	82.72

* Results significantly different from control at the 5 % level.

** Results significantly different from control at the 1 % level.